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Monthly Performance Report

HOWARD'S GROVE SCHOOL

MARCH 1979

U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

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MONTHLY PERFORMANCE REPORT
HOWARDS GROVE SCHOOL
MARCH 1979

I. SYSTEM DESCRIPTION

This solar energy heating system is designed to provide 58 percent of the space heating for an addition to the North View Elementary School in Howards Grove, Wisconsin. The addition contains 12,330 square feet of heated space. The collection subsystem has a total of 138 collectors arranged in six arrays each containing 23 flat-plate air collectors. The arrays, manufactured by Sun Stone Solar Energy Equipment, have a gross area of 2,685 square feet. The collectors face south at an angle of 50 degrees from the horizontal. Air is the medium used for transferring energy from the collector arrays to storage. Solar energy is stored in a 16- by 21- by 6-foot concrete block bin containing 1,500 cubic feet of crushed rock located below the equipment room. When solar energy is inadequate to provide space heating, auxiliary thermal energy is supplied from a 397,200 Btu/hr fuel oil boiler. The space heating control system modulates control dampers to mix outside air, return air and thermally heated air (solar and auxiliary) to maintain a building temperature of 67°F during the day and 55°F at night. (A minimum of 10 percent fresh outside air is required by law to be mixed with return air.) This system, shown schematically in Figure 1, has three modes of operation.

Mode 1 - Collector-to-Storage: This mode is entered when there is a difference in temperature of 17°F between the outlet of the collector arrays and the temperature at the bottom of rock storage. Air is drawn from the collector arrays, using the collector circulating fan F2, into the rock storage and recirculated to the collectors. Circulation continues in this mode until the difference in temperature between the collector outlet and bottom of rock storage is less than 4°F.

Mode 2 - Storage-to-Classrooms Occupied: This mode is entered using a seven-day clock with a manual override. Circulation fan F1 runs

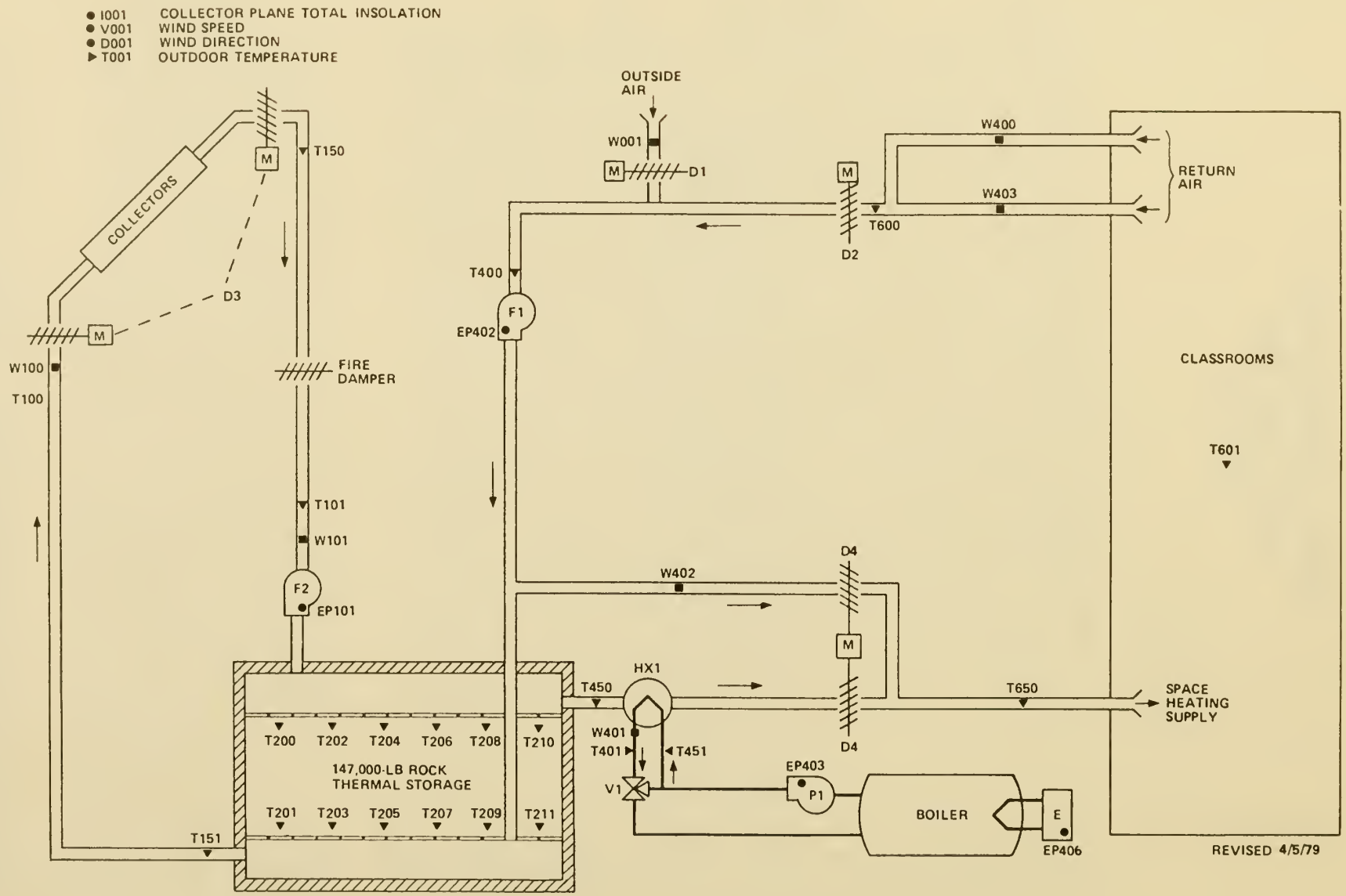

Figure 1. HOWARDS GROVE SCHOOL SOLAR ENERGY SYSTEM SCHEMATIC

continuously to transfer energy from storage and to provide ventilation. Outside air and return air dampers are modulated to supply fresh air at a mixed return air temperature of 60°F. Multizone control dampers modulate the mixed return air with thermally heated air from storage to maintain the design supply air temperature. The auxiliary fuel oil boiler supplements solar energy to meet the space heating demand and maintain the design internal temperatures. The seven-day clock terminates this mode at the end of each school day and on weekends.

Mode 3 - Storage-to-Classrooms Unoccupied: This mode is entered when there is a demand for space heating and the system is not in the occupied mode. The outside air damper D1 is closed. Multizone control dampers modulate the return air with thermally heated air from storage to maintain the design supply temperature. The auxiliary fuel oil boiler supplements solar energy to meet the space heating demand and maintain the design internal temperatures. This mode terminates when the demand for space heating ceases, or the system is changed to the occupied mode.

Mode 1 can be operating when Modes 2 and 3 are active.

II. PERFORMANCE EVALUATION

The system performance evaluations discussed in this section are based primarily on the analysis of the data presented in the attached computer-generated monthly report. This attached report consists of daily site thermal and energy values for each subsystem, plus environmental data. The performance factors discussed in this report are based upon the definitions contained in NBSIR-76-1137, Thermal Data Requirements and Performance Evaluation Procedures for the National Solar Heating and Cooling Demonstration Program.

A. Introduction

The solar energy system at the Howards Grove School site operated continuously during the month of March. The system supplied 23 percent

of the space heating demand of 66.88 million Btu. Operation of the solar energy system resulted in a savings of 20.26 million Btu of fossil fuel (140 gallons of fuel oil) at an expense of 2.3 million Btu (674 kwh) of electrical energy. The solar energy system performance continued to improve this month with the reduction in heating requirement and the improved collector subsystem performance.

A detailed discussion of the weather conditions and solar energy system thermal performance is contained in the following paragraphs.

B. Weather

March weather conditions were near normal. The measured outside ambient temperature was 31°F, which is only 1°F higher than the 30°F predicted from long-term averages. The measured wind velocity was 5 mph, less than the 12.2 mph predicted from long-term averages.

The cloud cover was above normal as indicated by a lower measured insolation as compared to the March predicted long-term monthly insolation. The measured insolation in the plane of the collector averaged 1,063 Btu/ft^2-day, which is less than the expected long-term average of 1,467 Btu/ft^2-day derived from measurements taken from an average of Green Bay and Milwaukee, Wisconsin, data.

C. System Thermal Performance

Collector - Of the 88.46 million Btu of solar energy incident on the collector array during March, 58.52 million Btu were incident on the array when fan F2 was operating. The system collected 17.28 million Btu, or 20 percent of the total insolation incident on the collector array. However, the collected energy represents 30 percent of the operational incident energy. The operation of the collector circulating fan F2 required 0.58 million Btu of electrical energy.

Storage - Of the 17.28 million Btu of solar energy collected, 16.96 million Btu were delivered to rock storage. A total of 0.32 million Btu

was lost in the collector-to-rock bed ducting. A total of 15.40 million Btu was extracted from storage and delivered to the space heating subsystem.

Space Heating Load - The space heating load was near normal because the average monthly temperature of 31°F was near the 30°F predicted long-term average for March. The 1,067 heating degree-days measured at the site is near the 1,085 heating degree-days predicted from long-term averages. The design heating load data for March was 86.3 million Btu from data supplied through the Department of Energy. However, the design heating load was calculated assuming that a large controlled infiltration of outside air exists during normal operation of the site. Also, environmental energy infiltration to the rock bed contributed to satisfying the space heating load. A total of 1.51 million Btu of environmental energy was stored in the rock bed. Therefore, a better method of determining the predicted space heating load had to be devised.

The method chosen was to use the building heat loss coefficient (UA) computed using the predicted design loads for December, 1978, and January and February, 1979, when little outside air infiltration exists. The computed UA for the period was 2,963 Btu/ft^2-day. The variance of the UA's for each of these months was less than 75 Btu/ft^2-day from the indicated average for the period. The space heating load predicted for March is 75.88 million Btu based on the measured 1,063 heating degree-days and the building UA value of 2,963 Btu/ft^2-day.

The measured space heating demand of 66.88 million Btu was satisfied by 15.4 million Btu of solar energy and 51.48 million Btu of auxiliary thermal energy resulting in a solar fraction of 23 percent. The 51.48 million Btu of auxiliary thermal energy for space heating were supplied by the consumption of 67.74 million Btu of fuel oil. This amounted to 469 gallons of fuel oil.

The analysis of the performance of the rock bed revealed that the large circulating fan added kinetic energy to the building circulation air

flow. This kinetic energy produced a 1.5°F temperature rise across the circulation fan and, thus, contributed to satisfying the space heating demand. The magnitude of the induced energy amounted to 4.79 million Btu during March. The measured space heating demand, when combined with the circulating fan and the environmental energy contribution to the space heating load, results in an indicated space heating demand of 73.18 million Btu, which compares well with the predicted load of 75.88 million Btu.

D. Observations

The performance of the solar energy system continued to improve over earlier winter months. The removal of the snow from the collectors in January was the major contributor to a better solar system performance. The collection subsystem performance is continuing to improve toward the expected performance of the subsystem.

In March, the reduced heating load allowed the building circulation fan to shut off when the control system switched from Mode 2 (Occupied) to Mode 3 (Unoccupied). The collector fan continued to run until later in the afternoon. The circulation fan shut-down reduces the rock bed interval pressure which, in-turn, allows the collector fan to operate more efficiently. The collector fan air flow to the rock bed increases from 3,400 to 4,950 cubic feet per minute. This condition is suspected to be exaggerated by collector leakage. The absorber plate temperature and collector outlet temperatures appear to verify this condition. Also, during the early winter months, a half-closed fire damper door caused an indication of unbalanced air flow to exist which substantiates the existance of collector leakage.

In addition to the collector array leakage, the collector array efficiency normally increases as the operating point moves from winter to spring. This is consistent with an air system in which the collector array return air temperature is nearly constant, which is the case for the Northview

Elementary School (Howard's Grove) solar energy system. As the ambient outside temperature rises, the operating point shifts toward lower values and the collector efficiency increases.

E. Energy Savings

The solar energy system installed in Howards Grove School resulted in savings of 20.26 million Btu (140 gallons) of fuel oil during March at an expense of 2.3 million Btu (674 kwh) of electrical operating energy. The space heating energy savings calculations are based on the energy requirements of a conventional propane-fired furnace with an efficiency of 76 percent compared to the energy requirements of the solar energy system.

III. ACTION STATUS

No outstanding action was pending at the end of March.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: HOWARDS GROVE SCHOOL, HOWARDS GROVE,WIS SOLAR/2041-79/03
REPORT PERIOD: MARCH,1979

SITE/SYSTEM DESCRIPTION:
THE HOWARD GROVE SOLAR ENERGY SYSTEM PROVIDES SPACE HEATING FOR A 12,330 SQUARE FOOT ADDITION TO THE NORTHVIEW ELEMENTARY SCHOOL IN HOWARDS GROVE, WIS. THE SYSTEM USES AIR AS THE ENERGY TRANSFER MEDIUM, 2685 SQUARE FEET OF COLLECTORS, TO COLLECT AND STORE SOLAR ENERGY IN A 1500 CU. FT. ROCK STORAGE UNIT. RETURN AIR FROM THE SCHOOL IS DIRECTED THROUGH THE ROCK UNIT FOR SPACE HEATING. AUXILIARY HEAT IS PROVIDED BY AN IN-DUCT HX SUPPLIED BY A FUEL OIL BOILER.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	88.460	MILLION BTU
	32940	BTU/SQ.FT.
COLLECTED SOLAR ENERGY	17.281	MILLION BTU
	6435	BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	31	DEGREES F
AVERAGE BUILDING TEMPERATURE	64	DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	0.17	
ECSS OPERATING ENERGY	0.581	MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	8.412	MILLION BTU
TOTAL ENERGY CONSUMED	93.435	MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	N.A.	66.881	N.A.	66.881 MILLION BTU
SOLAR FRACTION	N.A.	23	N.A.	23 PERCENT
SOLAR ENERGY USED	N.A.	15.397	N.A.	15.397 MILLION BTU
OPERATING ENERGY	N.A.	7.831	N.A.	8.412 MILLION BTU
AUX. THERMAL ENERGY	N.A.	51.484	N.A.	51.484 MILLION BTU
AUX. ELECTRIC FUEL	N.A.	N.A.	N.A.	N.A. MILLION BTU
AUX. FOSSIL FUEL	N.A.	67.742	N.A.	67.742 MILLION BTU
ELECTRICAL SAVINGS	N.A.	-1.718	N.A.	-2.299 MILLION BTU
FOSSIL SAVINGS	N.A.	20.259	N.A.	20.259 MILLION BTU

SYSTEM PERFORMANCE FACTOR: 0.698

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: HOWARDS GROVE SCHOOL, HOWARDS GROVE,WIS SOLAR/2041-79/03
REPORT PERIOD: MARCH,1979

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GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	93.326	GIGA JOULES
	374067	KJ/SQ.M.
COLLECTED SOLAR ENERGY	18.231	GIGA JOULES
	73075	KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	-1	DEGREES C
AVERAGE BUILDING TEMPERATURE	18	DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	0.17	
ECSS OPERATING ENERGY	0.613	GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	8.875	GIGA JOULES
TOTAL ENERGY CONSUMED	98.574	GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	N.A.	70.559	N.A.	70.559 GIGA JOULES
SOLAR FRACTION	N.A.	23	N.A.	23 PERCENT
SOLAR ENERGY USED	N.A.	16.243	N.A.	16.243 GIGA JOULES
OPERATING ENERGY	N.A.	8.261	N.A.	8.875 GIGA JOULES
AUX. THERMAL ENG	N.A.	54.316	N.A.	54.316 GIGA JOULES
AUX. ELECTRIC FUEL	N.A.	N.A.	N.A.	N.A. GIGA JOULES
AUX. FOSSIL FUEL	N.A.	71.468	N.A.	71.468 GIGA JOULES
ELECTRICAL SAVINGS	N.A.	-1.812	N.A.	-2.426 GIGA JOULES
FOSSIL SAVINGS	N.A.	21.373	N.A.	21.373 GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 0.698

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REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: HOWARDS GROVE SCHOOL, HOWARDS GROVE, WIS
REPORT PERIOD: MARCH, 1979

SOLAR/2041-79/03

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	4.944	31	0.774	N	0.037	N	0.157
2	0.980	31	0.452	O	0.000	O	0.461
3	0.846	35	0.131	T	0.000	T	0.155
4	1.158	35	0.106		0.006		0.091
5	1.439	28	0.034	A	0.000	A	0.023
6	5.908	30	0.827	P	0.044	P	0.140
7	0.792	32	0.638	P	0.000	P	0.806
8	1.276	34	0.099	L	0.000	L	0.077
9	0.946	32	0.059	I	0.000	I	0.063
10	5.629	8	0.764	C	0.044	C	0.136
11	2.986	14	0.155	A	0.011	A	0.052
12	6.297	25	0.886	B	0.046	B	0.141
13	5.073	37	1.051	L	0.042	L	0.207
14	4.945	21	1.174	E	0.033	E	0.237
15	*	*	*		*		*
16	5.861	30	0.935		0.053		0.160
17	1.321	34	0.392		0.004		0.297
18	3.885	40	0.266		0.039		0.068
19	0.589	41	0.718		0.000		1.219
20	3.318	38	0.528		0.033		0.159
21	1.505	37	0.313		0.000		0.208
22	5.382	36	0.846		0.047		0.157
23	0.244	40	0.457		0.000		1.874
24	0.726	22	0.327		0.000		0.451
25	2.222	18	0.011		0.000		0.005
26	5.346	20	0.744		0.047		0.139
27	6.483	22	1.090		0.055		0.168
28	0.467	34	0.567		0.000		1.214
29	0.965	35	0.101		0.000		0.105
30	1.311	44	0.076		0.003		0.058
31	2.764	33	0.379		0.018		0.137
SUM	88.460	-	15.397	N.A.	0.581	N.A.	-
AVG	2.854	31	0.497	N.A.	0.019	N.A.	0.174
NBS ID	G001	N113			G102		N111

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
COLLECTOR ARRAY PERFORMANCE

SITE: HOWARDS GROVE SCHOOL, HOWARDS GROVE, WIS SOLAR/2041-79/03
REPORT PERIOD: MARCH, 1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	4.944	3.859	1.384	36	0.280
2	0.980	0.000	0.000	32	0.000
3	0.846	0.000	0.000	*	0.000
4	1.158	0.219	0.046	39	0.040
5	1.439	0.000	0.000	29	0.000
6	5.908	5.153	1.847	34	0.313
7	0.792	0.000	0.000	34	0.000
8	1.276	0.000	0.000	39	0.000
9	0.946	0.000	0.000	37	0.000
10	5.629	4.692	0.831	*	0.148
11	2.986	0.799	0.103	20	0.035
12	6.297	5.397	1.838	33	0.292
13	5.073	4.553	1.359	44	0.268
14	4.945	3.205	0.607	23	0.123
15	*	*	*	*	*
16	5.861	5.158	1.476	*	0.252
17	1.321	0.252	0.047	39	0.035
18	3.885	3.457	0.998	*	0.257
19	0.589	0.000	0.000	*	0.000
20	3.318	2.791	0.847	41	0.255
21	1.505	0.000	0.000	42	0.000
22	5.382	4.922	1.779	41	0.330
23	0.244	0.000	0.000	45	0.000
24	0.726	0.000	0.000	*	0.000
25	2.222	0.000	0.000	19	0.000
26	5.346	4.477	1.247	25	0.233
27	6.483	5.888	1.926	29	0.297
28	0.467	0.000	0.000	*	0.000
29	0.965	0.000	0.000	34	0.000
30	1.311	0.103	0.045	51	0.034
31	2.764	1.706	0.345	34	0.125
SUM	88.460	58.516	17.281	-	-
AVG	2.854	1.888	0.557	35	0.195
NBSID	Q001		Q100		N100

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
STORAGE PERFORMANCE

SITE: HOWARDS GROVE SCHOOL, HOWARDS GROVE,WIS SOLAR/2041-79/03
REPORT PERIOD: MARCH,1979

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	CHANGE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	1.300	0.774	0.295	79	0.822
2	0.000	0.452	-0.416	75	1.000
3	0.000	0.131	-0.132	69	1.000
4	0.062	0.106	-0.020	67	1.369
5	0.000	0.034	0.037	68	1.000
6	1.738	0.827	0.639	80	0.844
7	0.000	0.638	-0.578	76	1.000
8	0.000	0.099	0.029	69	1.000
9	0.000	0.059	-0.020	70	1.000
10	0.863	0.764	-0.106	70	0.763
11	0.117	0.155	-0.014	66	1.213
12	1.714	0.886	0.632	78	0.886
13	1.327	1.051	0.095	85	0.864
14	0.613	1.174	-0.639	81	0.873
15	*	*	0.329	*	*
16	1.400	0.935	0.273	81	0.862
17	0.060	0.392	-0.399	83	-0.108
18	1.303	0.266	0.522	83	0.605
19	0.000	0.718	-0.572	79	1.000
20	0.816	0.528	0.243	78	0.944
21	0.000	0.313	-0.263	74	1.000
22	1.647	0.846	0.511	82	0.824
23	0.000	0.457	-0.468	80	1.000
24	0.000	0.327	-0.290	68	1.000
25	0.000	0.011	0.026	65	1.000
26	1.168	0.744	0.334	74	0.922
27	1.795	1.090	0.255	81	0.749
28	0.000	0.567	-0.388	76	1.000
29	0.000	0.101	-0.077	71	1.000
30	0.045	0.076	0.084	71	3.571
31	0.444	0.379	-0.071	72	0.694
SUM	16.959	15.397	-0.149	-	-
AVG	0.547	0.497	-0.005	75	0.899
NBS ID	Q200	Q201	Q202		N108

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE HEATING SUBSYSTEM

SITE: HOWARDS GROVE SCHOOL, HOWARDS GROVE,WIS SOLAR/2041-79/03
REPORT PERIOD: MARCH,1979

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR FR.OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	AMB TEMP DEG. F
1	1.861	42	0.774	0.264	1.087	N	1.430	-0.048	1.019	65	31
2	1.649	27	0.452	0.225	1.197	O	1.575	-0.045	0.595	64	31
3	1.392	9	0.131	0.161	1.262	T	1.660	-0.053	0.172	62	35
4	1.667	6	0.106	0.191	1.561		2.054	-0.071	0.139	62	35
5	2.616	1	0.034	0.314	2.583	A	3.398	-0.134	0.044	63	28
6	2.286	36	0.827	0.269	1.458	P	1.919	-0.056	1.089	64	30
7	1.994	32	0.638	0.274	1.356	P	1.784	-0.053	0.840	64	32
8	2.024	5	0.099	0.256	1.926	L	2.534	-0.101	0.130	64	34
9	1.811	3	0.059	0.221	1.752	I	2.305	-0.088	0.078	64	32
10	3.500	22	0.764	0.274	2.736	C	3.600	-0.067	1.006	62	8
11	3.277	5	0.155	0.303	3.122	A	4.108	-0.121	0.204	62	14
12	2.740	32	0.886	0.291	1.853	B	2.439	-0.055	1.166	64	25
13	1.911	55	1.051	0.238	0.860	L	1.131	-0.000	1.383	65	37
14	2.432	48	1.174	0.296	1.258	E	1.655	0.062	1.545	64	21
15	*	*	*	*	*		*	*	*	*	*
16	2.152	43	0.935	0.262	1.217		1.602	-0.069	1.230	65	30
17	0.881	45	0.392	0.090	0.488		0.643	0.027	0.516	63	34
18	0.958	28	0.266	0.106	0.692		0.910	-0.017	0.350	63	40
19	1.569	46	0.718	0.212	0.852		1.121	0.033	0.944	64	41
20	1.588	33	0.528	0.231	1.060		1.395	0.001	0.694	65	38
21	1.612	19	0.313	0.219	1.300		1.710	-0.062	0.411	65	37
22	1.738	49	0.846	0.249	0.893		1.174	-0.040	1.113	66	36
23	1.282	36	0.457	0.208	0.825		1.086	-0.008	0.602	65	40
24	4.338	8	0.327	0.426	4.011		5.278	-0.168	0.431	61	22
25	4.649	0	0.011	0.443	4.639		6.103	-0.196	0.014	61	18
26	3.113	24	0.744	0.349	2.370		3.118	-0.007	0.978	63	20
27	2.485	44	1.090	0.290	1.395		1.836	-0.062	1.434	64	22
28	1.669	34	0.567	0.214	1.102		1.450	-0.015	0.746	64	34
29	1.879	5	0.101	0.261	1.778		2.340	-0.103	0.133	64	35
30	1.564	5	0.076	0.218	1.488		1.958	-0.086	0.099	65	44
31	2.081	18	0.379	0.219	1.703		2.240	-0.061	0.498	63	33
SUM	66.881	-	15.397	7.831	51.484	N.A.	67.742	-1.718	20.259	-	-
AVG	2.157	23	0.497	0.253	1.661	N.A.	2.185	-0.055	0.654	64	31
NBS	Q402	N400	Q400	Q403	Q401		Q410	Q415	Q417	N406	N113

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: HOWARDS GROVE SCHOOL, HOWARDS GROVE,WIS
REPORT PERIOD: MARCH,1979

SOLAR/2041-79/03

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	1841	N	31	36	N	0	2
2	365	O	31	32	O	169	5
3	315	T	35	*	T	121	3
4	431		35	39		253	6
5	536	A	28	29	A	0	2
6	2200	P	30	34	P	177	2
7	295	P	32	34	P	19	4
8	475	L	34	39	L	0	2
9	352	I	32	37	I	251	7
10	2096	C	8	*	C	282	14
11	1112	A	14	20	A	267	6
12	2345	B	25	33	B	214	3
13	1889	L	37	44	L	238	13
14	1841	E	21	23	E	299	15
15	*		*	*		*	*
16	2182		30	*		223	5
17	492		34	39		172	2
18	1447		40	*		0	0
19	219		41	*		155	3
20	1235		38	41		283	3
21	560		37	42		0	1
22	2004		36	41		52	3
23	91		40	45		17	4
24	270		22	*		359	18
25	827		18	19		353	11
26	1991		20	25		305	3
27	2414		22	29		0	0
28	174		34	*		178	6
29	359		35	34		40	7
30	488		44	51		251	7
31	1029		33	34		30	6
SUM	32940	N.A.	-	-	-	-	-
AVG	1063	N.A.	31	35	N.A.	*	5
NBS ID	G001		N113			N115	N114

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